TOEROEK
ASSOCIATES, INC.

February 20, 2019

Ms. Shari Kolak
U.S. Environmental Protection Agency
Region 5
77 West Jackson Blvd., SR-6J
Chicago, IL 60604-3507

Re: Contract #EP-S5-15-08; TO 0648; Lake Calumet Cluster Superfund Site; CERCLIS Site ID: ILD000716852; SSID B58E; Draft Technical Reviews; Memorandum - Review and Assessment of Geologic Data on the Clay Confining Layer and Other Relevant Information at the Lake Calumet Cluster Site in Chicago, Illinois, dated October 31, 2018 and Surface Water Sampling Work Plan, Indian Ridge March, dated, August 30, 2018

Dear Ms. Kolak:

Toeroek Associates, Inc. ("Toeroek") is pleased to present our draft technical comments on two reports; the *Memorandum - Review and Assessment of Geologic Data on the Clay Confining Layer and Other Relevant Information at the Lake Calumet Cluster Site in Chicago, Illinois,* dated October 31, 2018 (Technical Memorandum) and, the *Surface Water Sampling Plan, Indian Ridge Marsh*, dated August 30, 2018 (SW Sampling Plan) under Contract No. EP-S5-15-08, Task Order (TO) 0648. The attached deliverables were reviewed by Toeroek as part of its quality assurance program as indicated in our Quality Management Plan.

We have included both Microsoft Word (.doc) and portable document format (.pdf) files of the draft comments for your use.

Please contact me at 312.212.0934 with any comments or questions related to the deliverable and we look forward to discussing these comments with you.

Sincerely,

Bradley K. Martin

Bradley K. Martin, P.E.
UROC Region 5/6 Program Manager

cc: Matthew Hoory, EPA Region 5
Robert Howe, Toeroek
Toeroek Project Files

TECHNICAL REVIEW
MEMORANDUM: REVIEW AND ASSESSMENT OF GEOLOGIC DATA ON THE CLAY CONFINING LAYER AND OTHER RELEVANT INFORMATION AT THE LAKE CALUMET CLUSTER SITE IN CHICAGO, ILLINOIS

DATED OCTOBER 31, 2018

I. General Comments

General Comment 1: Summary and Introduction – The *Memorandum: Review and Assessment of Geologic Data on the Clay Confining Layer and Other Relevant Information at the Lake Calumet Cluster Site in Chicago, Illinois*, dated October 31, 2018 (Technical Memorandum) indicates series concerns by the Lake Calumet Cluster Site (LCCS or Site); however, properly designed and installed deep wells pose little or no threat to the Silurian and other bedrock regional aquifer systems present beneath the Site. Such wells are necessary for understanding the hydrogeologic conditions at the Site that control the spread of contaminants to surrounding environs. Properly located and completed nested wells and surface water gauging stations are needed as described in more detail later in these comments to support the assessment of the clay confining layer as well as the OU2 groundwater and surface water sampling designs.

General Comment 2: Summary and Introduction - Available geotechnical data for fine grained glacial drift materials from the Wadsworth till in the northern Chicago area indicate the tills are primarily silty-clays with 50 percent or more silt and sand with moderate to low plasticity as opposed to clay. The plasticity is noted to depend on the grain size distribution[1]. The composition of the till beneath the Site needs to be analyzed for geotechnical and hydrologic properties before any conclusions can be drawn in terms of the storativity, transmissivity, and potential for contaminant seepage from fill through the glacial drift to the Silurian and other carbonaceous bedrock aquifers. More specifics concerning hydrogeologic and geotechnical tests suggested for performance are provided in the summary and conclusion comment at the end of this review.

[1] - The following publications provide information concerning the geotechnical and physical properties of the Wadsworth Till referenced as being present beneath the Site in the Technical Memorandum. The data contradicts the presumption that the Wadsworth Till is highly plastic as suggested by the authors in the Introduction and Summary section of this Technical Memorandum. These references include the following:

A) *Particularity of Plasticity Characteristics of Fine Glacial Materials (North Chicago Area)*, in Geo-Eco-Marina, July 2011. J. Constantines. See https://geoecomar.ro/website/publicatii/Nr.17-2011/07_constantinescu_BT.pdf
B) *Geology and Engineering Characteristics of Some Surface Materials in McHenry County, Illinois*, ISGS, January 1968. W. Calhoun Smith, in Environmental Geology Notes, Number 19. See https://www.ideals.illinois.edu/bitstream/handle/2142/78850/geologyengineeri19smit.pdf?sequence=1&isAllowed=y
C) *Chicago Underflow Plan, Phase II GDM, O'Hare Reservoir Phase II ..., Volume 1* Page C4-26. See https://books.google.com/books?id=Uyw0AQAAMAAJ&pg=RA5-PA26&lpg=RA5-PA26&dq=plasticity+of+the+wadsworth+till+chicago&source=bl&ots=ak4SsDXYo8&sig=ACfU3U241fKyrmo5RhoYPqVWtux1j7e8dQ&hl=en&sa=X&ved=2ahUKEwitzO7O_argAhUm0YMKHWdBBp8Q6AEwAHoECAUQAQ#v=onepage&q=plasticity%20of%20the%20wadsworth%20till%20chicago&f=false

General Comment 3: Geologic Data Review, Bullet 1 - The use of Illinois State Geologic Survey (ISGS) regional scale mapping of "glacial drift" and scant deep borings to estimate the lateral and vertical extent of fine-grained sediments beneath the Site is inadequate. For example, the statement in this section that the ISGS study indicates glacial drift are generally 100 to 200 feet thick at the Site, is not properly caveated with other evidence of drift thickness, such as the United States Geologic Survey (USGS) *Characterization of Fill Deposits in the Calumet Region of Northwestern Indiana and Northeastern Illinois*, Kay, 1997, which show in Figure 7 a glacial drift thickness at the Site of 50-75 feet. As noted in the Geologic Data Review, Bullet 1 of this Technical Memorandum, the ISGS maps define the approximate extent of "glacial drift" across the State of Illinois. By definition the deposits mapped by the ISGS as "glacial drift" include unconsolidated deposits, including glacial tills, outwash sands and gravel, and fine-grained stream and lake bed sediments. The ISGS makes no distinction between these differing lithologies that can have vastly different hydraulic conductivities. Regional mapping of the "glacial drift" unit by ISGS were likely performed through the use of aerial photographs and some limited boring log data, none of which, were from the Site.

General Comment 4: Geologic Data Review Bullet 2 - It is well documented in the USGS studies, *Geohydrology, Water Levels and Directions of Flow, and Occurrence of Light-Nonaqueous-Phase Liquids on Ground Water in Northwestern Indiana and the Lake Calumet Area of Northeastern Illinois*, Kay 1996 and the *Use of Isotopes to Identify Sources of Ground Water, Estimate Ground-Water-Flow Rates, and Assess Aquifer Vulnerability in the Calumet Region of Northwestern Indiana and Northeastern Illinois,* Kay 2002, that mining and landfill excavation activities have impacted the thickness of the glacial drift unit. Localized reef structures in the underlying dolomitic aquifer materials have also created structural highs in the underlying bedrock that can reduce the thickness of the glacial drift to less than 10 feet. Weathering, root casts, and other physical heterogeneities can also impact the flux of water through the glacial drift. Weathering and localized increases in hydraulic conductivities are expected in the upper 30 feet of the "glacial drift" unit (Kay, 1996). Further, impacts because of weathering are evidenced on many of the Hydraulic Profiling Tool (HPT) average pressure logs provided in Appendix C of the *Technical Memorandum: Groundwater Assessment Lake Calumet Cluster Site, Operable Unit 2"* (Arcadis, July 2017).

General Comment 5: Geologic Data Review, Bullet 2 - In this section of the Technical Memorandum the authors conclude that the thickness of the glacial drift unit thickens to the south towards the Site as compared to the deep soil borings on the former Interlake site located north of the Site. Presumably this conclusion is based on the regional mapping performed by the ISGS. This conclusion is contrary to the existing data from the deep boring immediately north of the Site drilled on Paxton 1 Landfill and the deep boring shown in Figure 3, Geologic Cross Section A-A' North to South, located on the northwest corner of the Site. The reason for the thinning of the glacial drift near and on the Site is unknown, but it could be the result of mining or landfill excavation.

Also, Figure 3 clearly depicts the fact that based on existing data; the glacial drift unit is no more than 57 feet thick beneath the northwest corner of the Site. Because increased weathering in the top 30 feet of the till has been noted by Kay 1996 and is evidenced in HPT logs, the till may or may not be adequate to protect the underlying Silurian and other carbonate regional aquifers present beneath the Site.

General Comment 6: Geologic Data Review, Bullet 3 – As noted by many authors and summarized well by Constantnescu (See General Comment 1, footnote 1), *2011 "Glacially derived deposits are among the most complicated of all geological environments, due to the fact that the motion of ice mixed together a large variety of materials. In general, the glacial materials have an overall appearance similar to the* *regular sedimentary materials, and are even labeled with the same terminology used for sedimentary deposits: gravel, and, silt, clay, etc. However, it is important to note from the beginning that the genetic mechanism imposed by movement of solid ice has little to no correlation to genetics processes of water based erosion, transport and deposition."* For this reason and considering observations discussed above by Kay 1996, the USGS 2002, and ISGS 1968, it is not appropriate for the authors of this Technical Memorandum to imply in Section 3 of the Geologic Data Review that *"The native clay confining unit encountered at the Site is a uniform, high-plasticity clay with no evidence of fractures or higher permeability seams present within the unit."* The glacial drift and related tills beneath the Site are part of complex lithologic units as indicated by the range hydraulic conductivities reported from well tests in the general area of the Site reported by Kay (1996) and discussed in this section

General Comment 7: Geologic Data Review, Bullet 3 – In this section a range in horizontal hydraulic conductivity values for the Wadsworth Till from Kay (1996) are presented; however, the horizontal hydraulic conductivity values reported by Kay (1996) were collected from slug tests performed in wells from weathered and unweathered portions of the glacial drift unit. Values were compiled from other studies conducted on other sites in the same general area, but not from the Site. As anticipated the range of hydraulic conductivity values reported for the glacial drift are broad as is the degree of weathering and compositional variations in the glacial drift deposit. The reported horizontal hydraulic conductivity values reported discussed by Kay (1996) range from 1.7×10^{-5} feet per day (ft/d) to 5.5×10^{-1} ft/d (6.0×10^{-9} centimeters per second [cm/s] to 1.8×10^{-4}cm/s). Slug tests were performed in 24 wells completed in the weathered zone in the drift and 18 wells completed in unweathered till zones. The median horizontal hydraulic conductivities reported by Kay (1996) of the weathered part of the confining unit were calculated to be 5.8×10^{-2} ft/d (2.0×10^{-5} cm/sec), whereas the median value for the unweathered part of the confining unit were calculated to be 2.8×10^{-3} ft/d (9.9×10^{-7} cm/sec). Permeameter tests at three sites near Lake Calumet and two sites in Gary indicate a range of vertical hydraulic conductivities in the glacial drift were from 3.7×10^{-6} to 1.6×10^{-3} ft/d (1.3×10^{-9} to 5.6×10^{-7} cm/sec).

Comparing these results to information provided for general lithologic types in Freeze and Cherry (1979) and Fetter (2001) the range in reported horizontal conductivity values for the glacial drift range from those of a silty sand down to silty clays, and clays (e.g., 1.0×10^{-4} to 1.0×10^{-9} cm/sec). Vertical conductivities are generally greater than horizontal conductivities, as noted by Kay (1996), in the Wadsworth glacial drift. However, permeameter data from near the Site and Gary Indiana suggest that vertical conductivities could be lower than is suggested by the horizontal conductivity results. Regardless, the potential for water to pass through the glacial drift beneath the Site could be highly variable.

As noted in General Comment 1, the glacial drift is expected to have moderate to low plasticity depending on the grain size distribution. Therefore, Site specific permeameter and slug test data are needed to evaluate the effectiveness of the glacial drift to protect the Silurian and other bedrock aquifers. This is particularly true, considering the thickness of the glacial drift beneath the Site is 57 feet, and could be less, if impacted by excavation. In addition, weathering may have impacted the upper 30 feet of the till making the undisturbed portion of the drift less than 30 feet thick.

In the State of Ohio (2009) aquitard guidance, 30 feet of a good aquitard material, such as a marine shale, with conductivities of less than 10^{-9} cm/sec are generally considered as a minimum thickness before protection can be demonstrated to be adequate. Given the conductivities expected in the glacial drift it is anticipated that a much thicker section of tight till will be required to provide adequate protection to the underlying Silurian and other bedrock aquifers.

General Comment 8: Tunnel and Reservoir Plan (TARP) System and Impacts to Bedrock Groundwater – The periodic changes to the hydrogeologic system near the Site as a result of the Tunnel and Reservoir Plan (TARP) system during periods of wet weather need to be considered when planning sampling activities and well development at the Site. During dry periods groundwater gradients may become increasing strong and downward in the shallower groundwater systems due to the water table drop in the Silurian bedrock aquifer noted in this Section. These components of the hydrogeologic model must be considered when designing when sampling and water level measurements are performed. The lowering of the Silurian aquifer during dry periods may increase infiltration rates from the Site to the Silurian bedrock aquifer. Head drops in the Silurian bedrock as a result of the TARP system are generally consistent except during periods of precipitation. Also, the Technical Memorandum indicates the groudnwater chemistry is affected by the TARP; however, documented releases from the TARP and contituent data from the TARP are not provided to support this assertion. It is unlikely that contaminats from TARP will overlap with organic contaminants expected to be present at the Site. Analyzing for fecal coliform should eliminate any questions concerning the potential influence of the TARP system. Regardless, the TARP system needs to be intergrated into the site-specific hydrogeologic model for the Site.

Summary and Concluding General Comments – Site specific information is needed to confirm many aspects of the aquitard beneath the Site before it can be considered as a viable portion of any groundwater protection remedy. At a minimum, a detailed site-specific hydrogeologic model with associated model related calculations are needed. Relevant information needs to be compiled and analyzed as the basis for the development of any groundwater or surface water sampling designs. Based on the site-specific data gaps present at the Site the following types of data may be needed, at a minimum, to verify the potential for the glacial drift beneath the Site to be confirmed as a protective aquitard.

1) Mapping of the top of the glacial drift and bedrock using geophysical methods. The data can be used to identify preferred pathways for groundwater. Geophysical data can also be used to identify localized topogrphic highs in the bedrock and the depth of excavation into the glacial drift. Both factors can result in a thininng of the aquitard beneath the Site. Geophysical methods may also be a viable options for estimating the thichness of the glacial drift across the Site.
2) Installation of nested wells completed near the water table, in the weathered top and lower unweathered portions of the glacial drift, and in the Sulurian bedrock aquifer at the dry period water table.
3) Electrical well logging.
4) Physical properties testing of the glacial drift beneath the Site, including multiple veritical intervals to assess phydical properties within the entire verical profile of the glacial drift. Geotechnical tests should include but not be limited to grain size analysis, liquid limit, plasticity limit/Atterberg limit, X-ray diffraction tests for clay minerology, permeability, and porosity.
5) Surface water and groundwater elevation measurements to evauluate groundwater and surface water flow directions and gradients.
6) Hydrogelogic testing including vertical conductivity testing in the glacial drift using a permeameter and horizontal conductivity testing using slug and or pump testing of select open intervals in the nested wells.
7) Sampling and analysis of groundwater and surface water for a full list of contaminants potentially present on the Site.
8) Evaluation of the use of isotopic age dating and tracers methods for predicting groundwater and surface water interactions.

Identification of all the specific data needs for evaluating the viability of the glacial drift to act as a barrier to flow from the fill to the Silurian bedrock aquifer and surrounding marshes is beyond the scope of these comments. The percise needs can only be determined through the application of the data quality objectived process. However, the following list of guidance documents are suggested as a starting point for the design of the aquitard evaluation process when combined with details of a site-specific hydrogeologic hydraulic models.

1) *Contaminant Transport Through Aquitards: Technical Guidance for Aquitard Assessment* Prepared by the American Water Well Association (AWWA) by Bradbury et al., (2006). See http://www.waterrf.org/Pages/Projects.aspx?PID=2780

2) *Contaminant Transport Through Aquitards: A State-of-the-Science Review and Technical Guidance for Aquitard Assessment* Prepared by the American Water Well Association (AWWA) by Bradbury et al., (2006). See http://www.waterrf.org/Pages/Projects.aspx?PID=2780

3) *Management of Contaminants Stored in Low Permeability Zones.* ER-1740 State of the Science Review Report, SERDP, 2013. See https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Persistent-Contamination/ER-1740/ER-1740-TR

4) *Aquitard Characterization.* March, 2014. State of Indiana Guidance. See https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_aquitard_characterization.pdf

5) *Assessment of an Aquitard during Ground Water Contamination Investigation,* November, 2009. See https://www.epa.ohio.gov/Portals/28/documents/TGM-Supp1.pdf

TECHNICAL REVIEW
SURFACE WATER SAMPLING WORK PLAN

INDIAN RIDGE MARSH

AUGUST 30, 2018

I. General Comments

Summary General Comment: The Lake Calumet Cluster Site (LCCS) Group should rethinking the overall design and timing for implementation of a surface water sampling effort in North Indian Ridge Marsh (NIRM or the Study Area) until after sufficient hydraulic and hydrogeologic data can be collected and analyzed to support a sound sampling design. The current design does not have a sound basis. Results from a study such as that proposed in the *Surface Water Sampling Plan, Indian Ridge Marsh*, dated August 2018 (SW Sampling Plan) may be inconclusive and result in data that is less than defensible to achieve the intended project objectives.

General Comment 1: Section 2, Background – It is unclear in Section 2, Background, of the *Surface Water Sampling Plan, Indian Ridge Marsh*, dated August 2018 (SW Sampling Plan) where and if groundwater is exiting to surface water in the North Indian Ridge Marsh (NIRM or the Study Area) from the LCCS (LCCS or the Site). Sources of relative recharge to the NIRM are not documented other than to mention the number of acres in the watershed as being 185 Acres. It is unclear how much of the surface water in the NIRM are expected to be as contributed from the LCCS as opposed to other sources such as the watershed, industrial sources, or the Calumet River. The successful performance of the proposed study as designed, to determine if LCCS groundwater impacts NIRM, assumes that the primary source of recharge to the IRM is from the LCCS. This is unlikely, given the geographic location and the expected influence from other sources of recharge to the NIRM. More information is needed in terms of the changes in water elevations in the NIRM and the remainder of the Indian Ridge Marsh and the other marshes adjacent to the Site. The gradients and direction of potential flow paths need to be analyzed such that sampling locations can be placed appropriately. Sampling locations need to target potential groundwater discharges from the Site to the surface water of NIRM. Creation of a water balance and hydraulic model for the Site and surrounding marsh areas would be helpful for selecting appropriate sample locations by further refining the project teams understanding of where potential impacts from the Site are expected to be evidenced.

General Comment 2: Section 2, Background - During wet periods it is highly likely that recharge to the NIRM by other sources of water such as precipitation and the Calumet River will act to dilute the evidence of any influence to the NIRM from the Site. Therefore, the timing for any surface water sampling event in the NIRM needs to be carefully selected based on a sound hydraulic and hydrogeologic model. A simple hydraulic and a hydrogeologic model need to be prepared and presented as the basis for any sampling design in this section of the plan. The LCCS working group may want to consider the collection of additional water level data over time, use of geophysical and tracer studies prior to attempting to design a meaningful surface water and groundwater/pore water sampling event in the NIRM.

General Comment 3: Section 3, Surface Water Collection Objectives – The objective of the SW Sampling Plan in the Study Area should also include an evaluation of potential impacts to shallow groundwater from the LCCS to the NIRM. Based on the fact that that standing water is present in the marsh areas during much of the year it is very likely that shallow groundwater gradients are almost always downward. Sampling exclusively surface water in the Study area and ignoring shallow groundwater on the Site and in the NIRM may completely or partially miss any influence from the Site to shallow groundwater beneath the surrounding marsh areas. Shallow groundwater should be considered as part of any surface water study unless it can be demonstrated that groundwater gradients are upwards everywhere between the marshes and the Site. The magnitude of gradients and expected flow directions must be considered before a sound sampling plan can be designed to evaluate impacts from the Site to surrounding water systems.

General Comment 4: Section 3, Surface Water Collection Objectives – Reference to the specific data quality assessment (DQA) protocols to be used to evaluate potential impacts from the Site to the NIRM should need to be provided. The DQA protocols should be provided in the Uniform Federal Policy Quality Assurance Project Plan (UFP -QAPP) as required under the Administrative Order on Consent.

General Comment 5: Section 3, Surface Water Collection Objectives - In this section and in Table 1 of this SW Sampling Plan, an analytical data reduction scheme is proposed to limit those analytes that will be used to evaluate surface water results. The scheme proposes pairing down the target analyte list by selecting only those analytes that have consistently been detected in each of the four former groundwater sampling events. Considering the fact that the project is in the early stages of remedial investigation process, it is not considered appropriate to use any type of target analyte reduction process at this point in time. Additional sampling and analysis are needed before EPA can consider focusing of the target analytes to a short list of indicator chemicals.

General Comment 6: Section 4, Sampling Design – In this section, the hydraulic and hydrogeologic data used to establish the design basis needs to be discussed with some level of detail and not completely ignored. Groundwater gradient and flow direction data along with surface water measurements and other relevant data need to be presented in the context of a site-specific hydrogeologic and hydraulic model for the LCCS and surrounding marshes. Preferential flow paths and potential source area water contributions need to be discussed. The type of data needed to support the study design basis should include, but not be limited to seasonal aerial photo interpretations, staff gauge measurements in the Study area, and water level and chemical data from paired wells along the boundary with the Study Area and the Site.

General Comment 7: Section 4, Sampling Design - The monitoring wells located along the boundary of the LCCS and the Study Area may not be comparable or representative of water expected to surface in the Study Area from LCCS. Water levels are near the surface in wells along the boundary between the LCCS and the Study Area, while screened intervals are much lower. For example, in MW-6, groundwater is at the surface, while the screened interval is in the waste at between 12 and 22 feet below ground surface (Reference: *Appendix E, Technical Memorandum: Groundwater Assessment, Lake Calumet Cluster Site Operable Unit 2, July 2017*). Groundwater at the surface in this well may be representative of precipitation which is the most likely water to be actively discharging to the Study Area unless vertical upward gradients can be shown to be present in the Study Area. The presence of upward gradients in the Study Area is unlikely given the apparent amount of recharge expected into the marshes surrounding the site. Use of shallow wells screened below the water table may be needed to evaluate the representativeness of the existing well data for comparison to surface water in the Study Area. Unless upward gradients are evidenced in the shallow groundwater in the Study Area deeper wells in addition to surface water samples may be needed to monitor for potential impacts from the LCCS. Geophysical and tracer study data could also be useful in determining where and when surface water or deeper pore water sampling is the most appropriate method of sampling at a specific location and depth.

General Comment 8: Section 4.1, Sampling Locations – Reference locations should be selected from areas north of the Study Area near the inlet to the marsh areas. Investigative samples of surface water (and potentially groundwater) should be focused where preferential pathways are expected to be present. For example, in the northeast corner of the LCCS where pump test data suggest the presence of high conductivities in the waste or in areas where consequence drainages cut the LCCS and may act to channel surface water and shallow groundwater into the Study Area. Localized drainages are evidenced in aerial photographs of the Site and could create localized areas with upward gradients in the Study Area. As previously noted, geophysical or tracer study data could also be useful in determining where the investigative samples in the Study Area should be taken.

General Comment 9: Section 5, Schedule and Reporting – It is very likely that hydraulic and hydrogeologic conditions change at the Site during alternating seasonal episodes of wet and dry conditions. Real-time monitoring of changes in water levels in the Study Area and in related groundwater are needed before the best time for sampling can be determined. In most cases to limit dilution from runoff surface water sampling in marsh areas are performed during periods of low flow (dry season). The exact time for sampling should be evaluated through the collection of continuous water elevation data. Timing of sampling efforts should also consider weather forecasts prior to conducting any sampling.